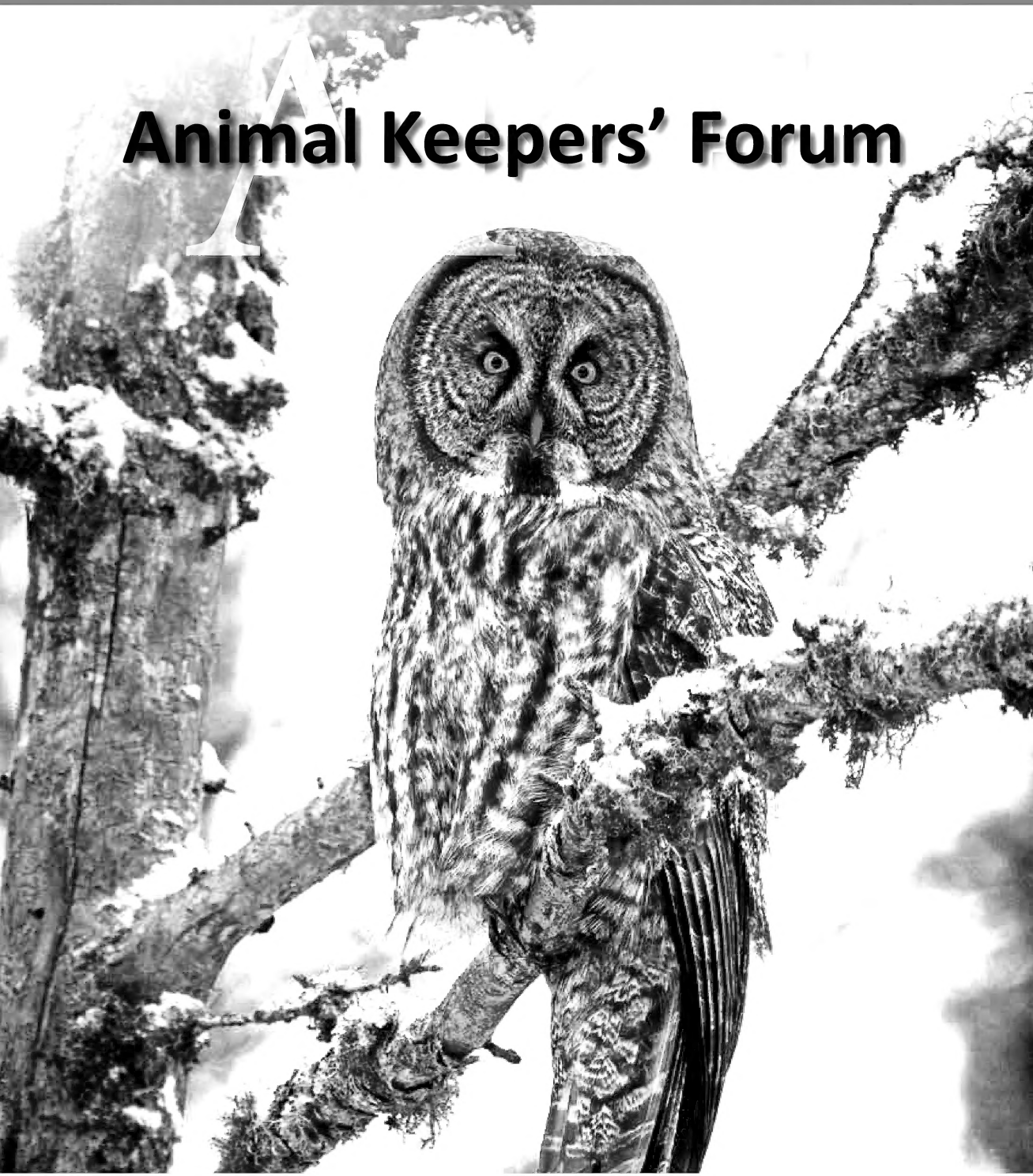
The Journal of the American Association of Zoo Keepers, Inc.

Animal Keepers' Forum



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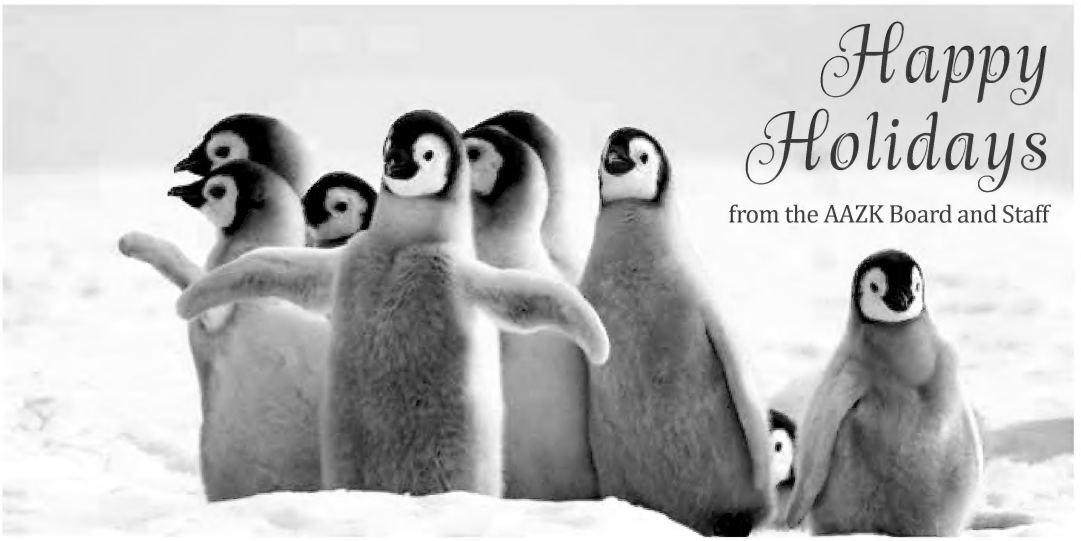

MISSION STATEMENT

American Association of Zoo Keepers, Inc.

The American Association of Zoo Keepers, Inc. exists to advance excellence in the animal keeping profession, foster effective communication beneficial to animal care, support deserving conservation projects, and promote the preservation of our natural resources and animal life.

ABOUT THE COVER

This month's cover photo features a great gray owl (*Strix nebulosa*) photographed at Sax Zim Bog in Northern Minnesota, by Eric Peterson of Viking Photography. A former zookeeper, Peterson stays active in the profession as a contributing photographer for the AZA's SAFE-North American Songbird Program.

The great gray owl is a very large owl, documented as the world's largest species of owl by length. It is distributed across the Northern Hemisphere, and it is the only species in the genus *Strix* found in both the Eastern and Western Hemispheres. The harvest of timber from the great grey owl's habitat is, perhaps, the greatest threat to this species. Intensified timber management typically reduces live and dead large-diameter trees used for nesting, leaning trees used by juveniles for roosting before they can fly, and dense canopy closures in stands used by juveniles for cover and protection. If perches are not left in clearcuts, great grey owls cannot readily hunt in them.

Articles sent to *Animal Keepers' Forum* will be reviewed by the editorial staff for publication. Articles of a research or technical nature will be submitted to one or more of the zoo professionals who serve as referees for *AKF*. No commitment is made to the author, but an effort will be made to publish articles as soon as possible. Lengthy articles may be separated into monthly installments at the discretion of the Editor. The Editor reserves the right to edit material without consultation unless approval is requested in writing by the author. Materials submitted will not be returned unless accompanied by a stamped, self-addressed, appropriately-sized envelope. Telephone, fax or e-mail contributions of late-breaking news or last-minute insertions are accepted as space allows. Phone (330) 483-1104; FAX (330) 483-1444; e-mail is shane.good@aazk.org. If you have questions about submission guidelines, please contact the Editor. Submission guidelines are also found at: aazk.org/akf-submission-guidelines/.

Deadline for each regular issue is the 3rd of the preceding month. Dedicated issues may have separate deadline dates and will be noted by the Editor.

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Diversity in the Association and the profession is integral to a successful workforce, and we recognize the work that needs to be done to serve all in our membership.

"As animal keepers, we are granted the ability to engage with millions of zoo and aquarium visitors each year on topics such as environmental conservation, the preservation of natural resources, and animal biodiversity. Minorities and their communities across the globe continue to lawfully assemble and demonstrate in opposition to systemic racial inequalities and violence, and we stand by them. We recognize that people of color are underrepresented in our profession and we must work on acknowledging, listening to, and learning about community concerns at this time. Diversity in the Association and the profession is integral to a successful workforce, and we recognize the work that needs to be done to serve all in our membership. Today's keepers are tomorrow's hiring managers and AAZK hopes that our membership boosts the inclusion of minority interest, understanding, and presence in the animal care profession."

Above is the statement of AAZK on racial equality released in June of this year. Inequalities in the field of animal care must be addressed if zoos and aquariums hope to connect with the diverse audiences that visit each year. The Association's statement on the matter is an important step, but a statement means little if no actions are taken to improve diversity, equity, and inclusivity in our profession. Several local Chapters held panels where discussions on these topics were held to inform their Chapter members on experience and activities in the realm of diversity. AAZK is also pursuing efforts to support racial equity at the national level.

The AAZK Board of Directors recognized the need to bring in professionals familiar with the topic of diversity in our field to help guide the organization. This led to the formation of the AAZK President's Task Force on Diversity. Initially reaching out to members who held workshops on diversity at recent AAZK National Conferences, the task force has now begun work with a team of eight individuals guiding the organization. This task force will work to increase opportunities to diversify the animal care profession by encouraging the recruitment, development, mentoring, and retention of animal keepers from all backgrounds. The AAZK Grants Committee is also hard at work in the creation of a Student Diversity Grant aimed at minority students working toward entering the animal care profession. The grant as well as upcoming efforts such as the addition of improved language in support of diversity in the organization as well as member demographic surveys will be the first steps to supporting growth of diversity, equity, and inclusion in our field.

Cheers,

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Cotton-Top Tamarins: The importance of natural cooperative care behaviors in a managed setting

Elizabeth Fochtman
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Introduction

Cotton-top tamarins *(Saguinus oedipus)* are critically endangered primates found only in northern Colombia (Price, 1990). These small New World monkeys are easily recognized by their crest of long white hair on the top of their heads. They move around using quadrupedal locomotion through multiple layers of the forest, from the understory to the canopy. In the wild, the cotton top's diet includes fruits, insects, and nectar (Cawthon, 2005). In human care, they enjoy a similar diet, which also includes vegetables, Marmoset chow*, Callitrichid gel* and fresh cut browse (a variety of plants, tree trimmings, and flowers).

These small primates were classified as an endangered species in 1973 after an estimated 20,000-40,000 tamarins were exported to the United States to be used in biomedical research (Hoffner, 2018). Following a census of the wild population in Colombia in 2005, where only 1,900 cotton-top tamarins were found, the species was upgraded to the status of critically endangered by the International Union for Conservation of Nature in 2008 (Hoffner, 2018). This brought to light the need for conservation programs to protect this species (Savage et al., 2016). Conservation efforts for the species have made significant advances toward developing a self-sustainable captive breeding population, largely due to the efforts of the Association of Zoos and Aquariums (AZA), and their Species Survival Program (SSP) (Hoffner, 2018). This program now has over 300 cotton-top tamarins managed in more than 80 AZA accredited zoos in the United States (Hoffner, 2018).

Like all tamarin species, cotton top tamarins use cooperative care to raise young within the colony. Cooperative care is a strategy used in groups where individuals help raise offspring that are usually related to them but are not their own (Zahed et at., 2010).

Photo by Phoenix Zoo Senior Primate Keeper Amy Dietz

Some of the benefits of a cooperative care strategy include breeders gaining fitness by lowering their energy costs and helpers gaining fitness by ensuring siblings survive that carry their same genetics (Price, 1990). In the wild, cotton-top tamarins commonly live in groups of three to nine individuals (Zahed et al., 2010). However, the colony will only have one breeding pair, with the dominant female suppressing the other females' ability to breed through hormone suppression (Snowdon and Cronin, 2007). This means the dominant breeder's other offspring only have the opportunity to gain fitness by helping their parents raise their siblings.

Cooperative care is also important to the survival of infants in tamarin colonies because new, inexperienced parents are more likely to reject or fail to successfully raise their offspring than experienced parents (Snowdon and Cronin, 2007). In one study, the survival rate of infants with mothers who had previous infant care experience prior to mating was 81%, compared to 43% infant survival rates for mothers with no previous experience (Cleveland and Snowdon, 1984). Infants are carried on the parent's back exclusively for the first month of life (when no helpers are available), and then on and off for the next few months. This can be physically exhausting for the parents, and tamarins are known to lose up to 10% of their body weight during this time (Snowdon and Cronin, 2007). Research has shown that the more helpers available, the less weight parents are likely to lose (Snowdon and Cronin, 2007). These helpers are mostly older siblings in captivity, but also may be unrelated members of the group in the wild (Cawthon, 2005).

The Arizona Center for Nature Conservation (Phoenix Zoo), an AZA-accredited facility, participates in the cotton top tamarin Species Survival Program and aims to aid in the SSP's goal of developing a healthy ex-situ population and prevention of species extinction (Phoenix Zoo, 2018). The colony of cotton-top tamarins housed at the Phoenix Zoo consists of a single breeding pair, Stripe (male) and Lola (female). On the 26th of October, 2017, the colony expanded with the birth of female twins, which is more common for callitrichids over producing a single offspring (Zahed, 2010). In the wild, a tamarin's ovulation is linked to the season and food availability (Cawthon, 2005). However, the captive tamarin reproductive cycle allows them to become pregnant almost immediately after giving birth, with pregnancy lasting about 130-183 days (Zahed, 2010). In June of the following year, Lola gave birth to her second set of twins, one male and one female.

Code	Description
T-I	Older sibling attempting to touch infant
T	Older sibling touching infant
A-P	Older sibling attempting to take infant from parent
A-I	Older sibling attempting to take infant that is independent from parent
C-P	Older sibling taking infant from parent and carrying
C-I	Older sibling taking infant that is independent from parent and carrying
A-F(NV)	Older sibling attempting to food share with infant without verbalizing
A-F(V)	Older sibling attempting to food share with infant while verbalizing
F-NV	Older sibling food sharing with infant without vocalizing
F-V	Older sibling food sharing with infant while vocalizing
A-NP	Aggression (Non-physical) from older sibling toward infant
A-P	Aggression (Physical) from older sibling toward infant
P	Older sibling engaging in play with infant(s)

Table 1. Code behavior and definitions.

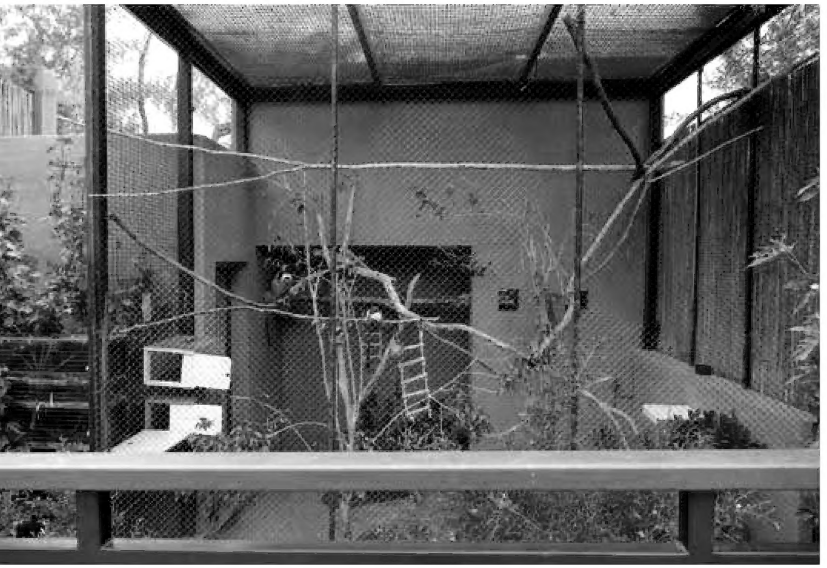
Lola and Stripe's first set of twins, Marimonda (Mari) and Tunda, who were approximately seven months of age at the time of their younger siblings' birth, will be extremely important to the success of their sibling's upbringing. They should share in the burden of carrying the infants, and aid in teaching the infants important lessons, such as which foods are of the highest value, and how to avoid predators (Zahed et al., 2010). They should also assist in teaching them foraging behavior prior to weaning, which occurs between four and seven weeks (Snowdon and Cronin, 2007).

It is important that animals in captive care exhibit natural behaviors as they would in the wild for their physical well-being and mental health, as it could affect how successful they are at producing offspring. Behavior for successfully raising offspring is learned and not instinctual (Cawthon, 2005). At the Phoenix Zoo, Mari and Tunda are learning from their parents how to successfully raise offspring so they will have the skills and knowledge to properly care for their own offspring in the future. However, as this is the older twin's first experience with infant care, it leads to the question, how will their behaviors compare to natural behaviors seen by both wild and captive tamarins in other studies? This study will examine this question, as well as look at how the older twins' care compares to one another, and what factors might influence behavioral differences.

Methods

Observations were carried out while the colony was in full view of the public in their exhibit. The exhibit is constructed out of 1"x3" wire on 3 sides with a solid wall along the back and a dirt floor. Inside the exhibit, there are live plants, wood perching, and various movable structures for climbing. The colony also has access to an off-exhibit nestbox, which is not viewable for public and no observations were made in this area. All individuals were normally housed together at all times, and only removed for exams or medical purposes.

An ethogram was created which consisted of behaviors related to cooperative care (Table 1). The ethogram was specific to behaviors between the older set of tamarin twins, females Mari and Tunda, which were born on the 26th of October, 2017, and the new set of infant twins, which were



Cotton-top tamarin exhibit at the Phoenix Zoo. Photo by Elizabeth Fochtman.

born on the 1st of June, 2018. These behaviors were taken from similar studies done on cooperative care in captive cotton-top tamarin colonies, and reflect general behaviors that should be taking place in captivity or the wild. Aggression was placed in the ethogram for the keeper's personal records, and was not used for the purpose of this study. The ethogram included behaviors from the older siblings towards the infants in two forms, attempting the behavior or actually performing the behavior. The behaviors recorded were: touching, taking from a parent and carrying, taking when independent of parent and carrying, food sharing while vocalizing, food sharing without vocalizing, physical aggression, non-physical aggression, and engaging in play.

The entire observation period was done over the first three months of infant development, from the date of infant birth, June 1, 2018 to August 31, 2018. However, no observations were carried out in weeks seven and eight due to the older siblings being absent from the exhibit for medical purposes. The observation period of three months was chosen because this is the time when the tamarins are the most reliant and learn the most from their parents and siblings (Snowdon and Cronin, 2007). The ethogram was used to record personal observations, which were the main form of study. Personal observations were carried out once a day in the afternoon, three times a week for a period of 20 minutes. The ethogram was also posted along with a log sheet in the keeper area of the tamarin complex exhibit. From the infant's' birth, the keepers working that area recorded data that they observed based on the behaviors on the ethogram. Keeper observations were carried out three times a day during cleaning and feeding times. There was no set time for keeper observations, they were simply asked to record any behavior they witnessed while servicing the exhibit. This consisted of the primary keeper of the area most of the time, but also included a variety of eight other keepers, including other primate and relief keepers.

A camera trap was also placed in the exhibit to collect video data to supplement direct observations. This also allowed for the collection of unbiased data, as captive animal behaviors can vary if there is any individual present. Although the parents have previous experience with the camera trap, none of their offspring had any previous exposure so there is little risk of it influencing the specific behaviors being monitored for this study. The camera trap was set to record 20 seconds of video when triggered by movement at any time and set to rest for the length of one hour after the initial trigger to keep recorded data at a manageable amount. The camera traps were active for the last two months of data collection. This video was then viewed and any behaviors that were observed were recorded in order by date.

Results

A total of 25 20-minute personal observations were carried out, 35 ethogram log entries were made by keepers, and approximately 750 videos were reviewed from the camera trap. A total of 52 behaviors were recorded over the three-month period (Figure 2), with the first behavior recorded on Day 6 as one of the older twins, Tunda, attempted to touch an infant. She was then observed touching an infant five more times that first week. The 13th day was the first time Tunda was seen taking an infant and carrying it. Tunda was then observed carrying infants with consistent numbers from week three to week six, with a peak of carrying observed in weeks five and six. Following week six, the carrying tapered off and mostly play behaviors were seen. The other older twin, Mari, was observed showing more touch behaviors throughout the study, but was only observed carrying an infant in weeks five and six. She was also observed exhibiting play behaviors in the same later weeks as her twin, Tunda. Behaviors involving food sharing were only observed one time from each twin on the same occasion and no aggressive behavior was seen.

Discussion

Observations began the day the infants were born, however, no behaviors were observed and recorded until the 6th day. One reason for this could be that the family spent most of the first days in a nest box, a box structure connected to their outside area. This enclosed area is mostly concealed and the colony was given extra space to feel comfortable and secure. It is possible that behaviors were displayed that were not seen. In the wild, mothers and fathers do

most of the carrying initially due to a constant feeding schedule with the infants (Price, 1992). Mothers are the primary caregiver immediately after birth (Achenbach and Snowdon, 1998) and tend to keep potential helpers away at first (Price, 1990).

Tunda was seen carrying for the first time at the end of Week 2, which is believed to be the first time she successfully carried an infant. According to Achenbach and Snowdon (1990), siblings are rarely seen carrying in the first two weeks; however, Zahed et al. (2010) states that helpers may start carrying as early as Day 1. Siblings carry the most during Weeks 3-6, with declined carrying seen in Weeks 7-10 (Achenbach and Snowdon, 1990). This supports Tunda's observed behavior. Another study states that peak carrying time for siblings is in Week 7, which coincides with parents' peak refusal to carry (Zahed et al., 2010). Both twins peak carrying behaviors were seen in Weeks 5 and 6, however, they were absent from the exhibit for Week 7 so no observations were able to be made. Infants should be completely independent of carrying by Week 12. At this point only Mari was observed carrying on one occasion (Figure 3).

While Tunda's behavior supports outside research mentioned in this study, Mari showed slower development in her care, as well as being observed exhibiting helper behaviors less. This observation is likely due to Mari being absent from the family for a period of six days from the 6th of June until the 12th of June for medical reasons. She was also removed for another period from July 6th to August 10th due to continuing medical issues, and her twin was taken with her as support for approximately two weeks. During these weeks, Weeks 7 and 8 of the study, no data were recorded due to the older twins being away from the colony.

While Tunda's absence did not seem to affect her care behavior, Mari was absent for critical time periods shortly after the infant's births where learning important lessons on care from parents may have been occurring. This may have contributed to her showing less care toward the infants. However, she was still observed interacting with them

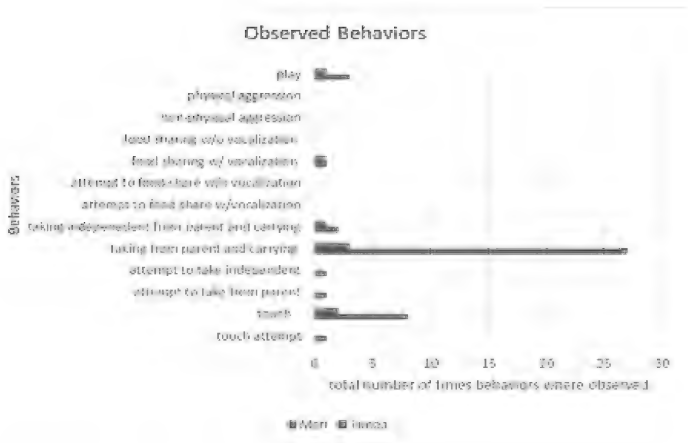


Figure 2. All recordable observed behaviors by older siblings over 3-month period.

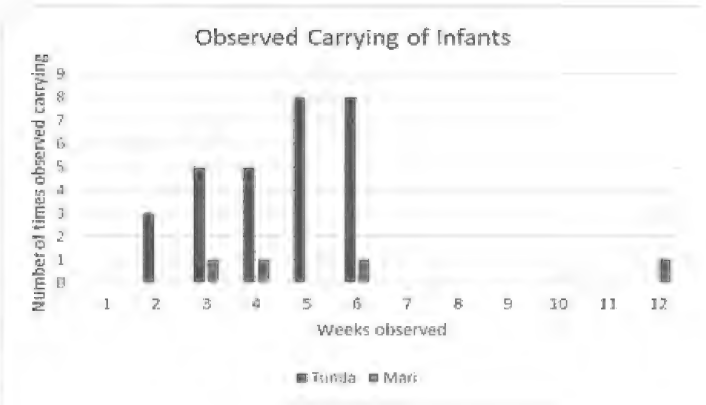


Figure 3. Amount of observed carrying behaviors performed by each older sibling

and no aggression or negative care was observed. Her medical condition, which may have left her with developmental issues, could also account for her showing less cooperative care when compared with her sister. Zahed et al. (2010) found in their study that even with variation in care behaviors by individuals in a colony, infants still received equivalent care due to the cooperative nature of the group as a whole.

Food sharing was not an observed behavior for either older sibling, which could be attributed to a lack of experience (Price, 1992). Keepers reported observing the infant twins begging for food in the early stages of their weaning. However, once the infants became more confident, they were observed multiple times simply taking the food from their parents and older siblings. This behavior was not defined and could not be recorded as "sharing." In future research, both begging and food stealing would be included in the ethogram to get a better idea of whether food sharing is not being taught by the parents or if this is just an individual case of behavioral differences in a group. Epple (1975) believed that tamarins may need experience from more than one set of infant siblings to develop proper parental care behaviors. If this is the case, the older twins would need to gain experience from at least one more set of siblings to be consistent with their

care behaviors and truly be successful as mothers themselves.

Conclusion

Although only one of the twins showed behavior consistent with previous studies on cooperative care behavior, it is believed that the other's behavior can be explained by extenuating circumstances, and that she eventually caught up to a similar level of care behavior as her twin. Although variation in care behavior by individuals does not seem to affect infant care as a whole within a group (Zahed et al., 2010), the older siblings may need to gain more experience from participating in the care of another set of infant siblings before they have fully learned all of the knowledge they need to become successful mothers in the future (Epple, 1975). In the wild, inexperienced adults become unsuccessful caregivers (Cawthron, 2005). Therefore making sure individuals have acquired enough knowledge to be successful caregivers before becoming part of the SSP must be considered in managed care as well.

The data collected from this study can contribute to the overall data on cooperative care in cotton-top tamarins, and possibly be relevant to future studies on the same colony at the Phoenix Zoo. Overall this colony had a successful year breeding two sets of twins, which greatly contributes to the critically endangered cotton-top tamarin population. Both sets of twins have developed into healthy, active individuals. This can be partially attributed to their keepers, managers, and vet staff at the Phoenix Zoo and partially attributed to the cooperative care that has been successfully displayed by the parents and siblings of this colony. It is important that these natural species-specific behaviors are seen in managed groups, which reflect professional knowledge of the species and that they are provided the proper environment to thrive. If not, studies have shown that unnatural or stereotypic behaviors may be seen that could be detrimental to future attempts at successful parenting (Cleveland and Snowdon, 1984). Because of this, cooperative care is an essential part of the behaviors that are required for successful breeding of the species, and helping to maintain a healthy and sustainable population.

Photo by Phoenix Zoo Senior Primate Keeper Amy Dietz

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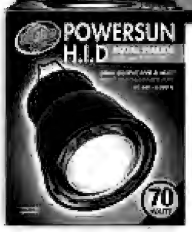

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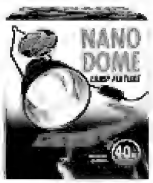

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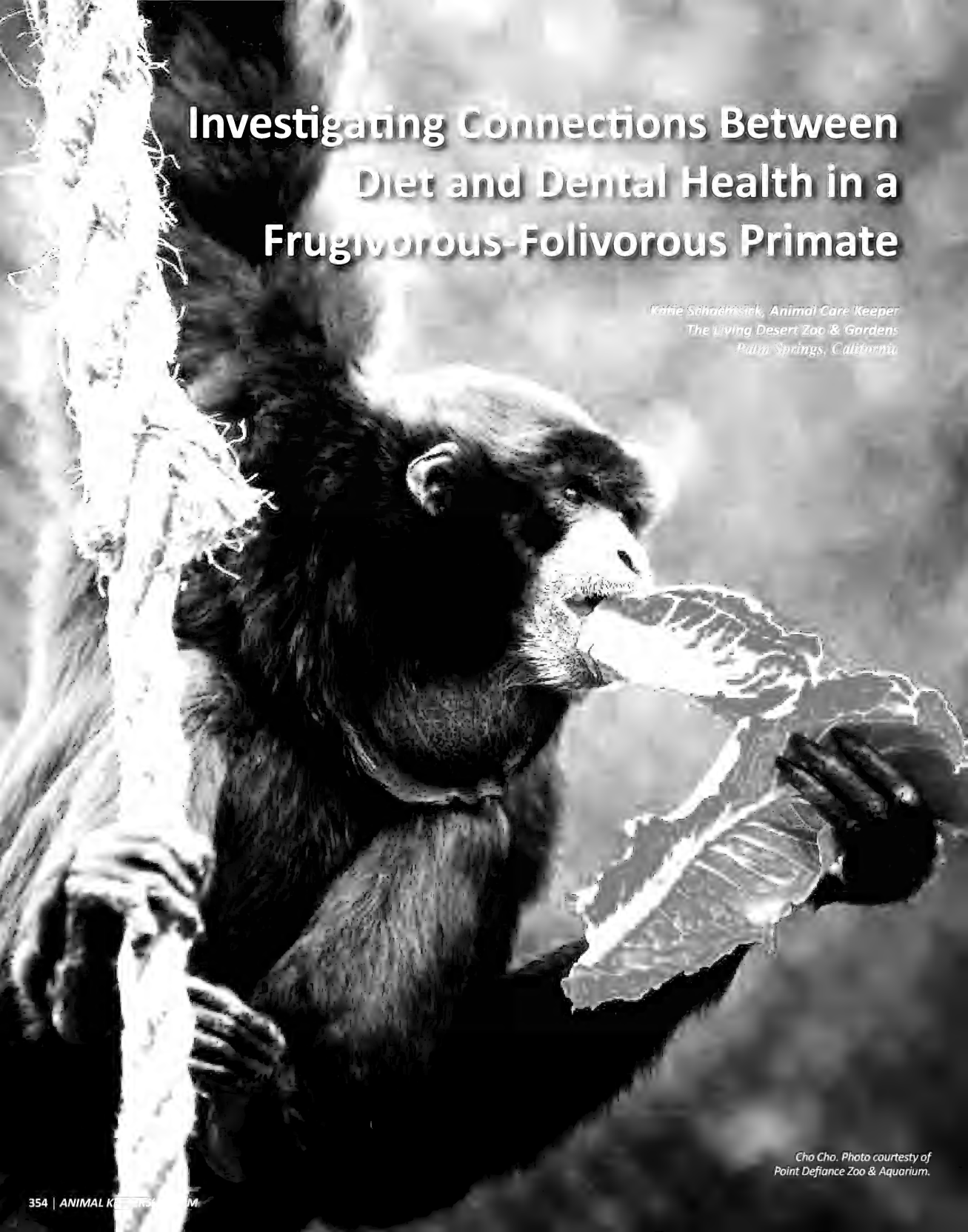

Cho Cho. Photo courtesy of Point Defiance Zoo & Aquarium.

Introduction

The siamang (*Symphalangus syndactylus*) is a species of lesser ape native to Southeast Asia. Siamangs have been described in literature as folivores, frugivores, or "fig-seekers" (Elder, 2009). The morphology of their gut suggests that they are more frugivorous than folivorous (Orgeldinger, 1995). However, wild siamangs eat a higher amount of leaves than other sympatric gibbon species (Harrison & Marshall, 2011).

The captive diets of siamangs have traditionally been formulated and fed based on the personal experience of zookeepers and what other facilities have fed their animals rather than on scientific research (Orgeldinger, 1995). In 2011, there were 341 individuals from nine gibbon species in facilities accredited by the Association of Zoos & Aquariums (AZA), but there is still no animal care manual for lesser apes provided by the organization (AZA, n.d.; Melfi, 2012).

While caring for two aging siamangs, I began to wonder if there were any dietary changes that should be made to mitigate their health issues. Specifically, both animals have had teeth removed in recent years. I was unable to find any existing studies on how diet affects a siamang's dental health. I became curious- are zoo siamang diets striking the proper frugivore-folivore balance? If not, is this negatively affecting the dental health of captive siamangs?

Diet and Dental Health

Dental health is an important yet somewhat overlooked aspect of animal health. Furthermore, diet and dental health have a strong and complex connection. Diet affects dental health in two primary ways: nutritionally and mechanically.

Proper nutrition is important for the formation and maintenance of teeth. Phillips-Conroy and Jolly (1988) found that certain teeth of captive yellow baboons (*Papio cynocephalus*) erupted earlier than in their wild counterparts, likely due to improved nutrition. There can also be consequences to the direct contact of teeth and food due to its nutritional properties. Cabana and Nekaris (2015) evaluated the diets of captive pygmy slow lorises (*Nycticebus pygmaeus*) and found a correlation between high amounts of fruit and dental disease.

The mechanical properties of a diet can also affect an animal's dental health. Being fed an excess of foods of improper texture or firmness can damage teeth or cause morphological changes such as tooth crowding and altered jaw musculature (O'Regan & Kitchener, 2005). Inversely, damaged or missing teeth can affect an animal's nutritional intake. Dental impairment can limit a primate's ability to properly digest food due to decreased masticatory function (Cuozzo, Ungar, & Sauther, 2012). Humans with tooth loss have been known to alter their eating habits, gravitating toward softer foods and away from foods such as nuts, fruits, and vegetables (Schimmel, Katsoulis, Genton, & Müller, 2015). It is feasible that similar changes could occur in other species when offered foods that have become difficult or painful to eat.

My Study

I decided to investigate if the amount of fruit or the amount of leafy greens in a siamang's diet were more closely correlated with their dental health. I created a survey using surveymonkey.com, which was sent out to members of the siamang Species Survival Plan (SSP). The survey was comprised of the following questions:

1. What is the name of your facility?
2. How many siamangs does your facility house? Please use 0.0.0 numbering.
3. What diet do your siamangs receive on a daily basis? Please include type of food, amount, and units.
4. Is this the amount offered to each individual or to the entire group?
5. For each of your siamangs, please list their age and rate their dental health on a scale of 1-5.
   Examples of each rating-
   1. substantial tooth wear, gingivitis, and missing teeth
   2. one or two of the above problems, or all of them to a lesser degree
   3. one or two of the above problems to a lesser degree
   4. age-appropriate tooth wear, some gingivitis, possibly a missing tooth
   5. better than average tooth wear, little to no gingivitis- most animals will not fit perfectly in these ratings, best approximations are perfectly acceptable!
6. Why did you give these ratings?
7. Additional comments?

After receiving responses, I calculated the average amount in grams of greens and fruit in grams which each siamang received daily. Any diet items received weekly were included, but their amounts were divided by seven. In instances where either one amount of an item or another amount of a different item were offered, these amounts were averaged.

When calculating the amount of fruits, I included fresh fruits, dried fruits, and fruit products such as applesauce. Scheduled food enrichments and foods regularly provided for medical purposes were also included in my data. I had originally planned to include browse in the "greens" category, but no respondents indicated that their siamangs regularly received browse. I had not anticipated the frequent presence of browse

Siamang Diets and Dental Health Ratings

Individual	Amount of daily greens	Amount of daily greens and browse biscuits	Amount of daily fruit	Dental health rating
1	381.2g	466.91g	300g	3
2	381.2g	458.34g	250g	4
3	238g	388g	612.25g	5
4	238g	388g	679.15g	5
5	312.25g	312.25g	25.5g	4
6	312.25g	312.25g	25.5g	4
7	331.12g	435.45g	81.65g	4
8	331.12g	435.45g	81.65g	4
9	264g	299g	157.13g	3
10	450g	630g	157.13g	4
11	720g	800g	228.7g	4
12	720g	800g	228.7g	5

Figure 1. Data collected during the study.

Cho Cho. Photo courtesty of Point Defiance Zoo & Aquarium.

biscuits or "leaf eater" biscuits in many of the diets submitted. I ultimately processed two sets of "greens" data, one including and one omitting these biscuits.

For certain types of foods, facilities reported offering a number of items rather than an amount. In these instances, I estimated the amounts through either an internet search or by weighing a similar item. One facility reported feeding out one head of a different type of greens each day. I was able to find estimates for all types of greens except for two. For the weight of these items, I used the average of the other five.

I calculated the Pearson product-moment correlation coefficient of the dental health rating with the siamangs' daily amount of greens, greens and browse biscuits, and fruit using Google Sheets. I also determined the significance of each result using a two-tailed t-test. Additionally, I found the percentages that the categories filled in each individual siamang's diet.

Results

I received a total of five responses with information on 12 individual siamangs. The daily amount of fruit in an individual's diet ranged from 25.50g to 679.15g, with an average of 235.70g. The amount of greens ranged from 238g to 720g, with an average of 389.93g. Individuals' daily browse biscuits ranged from 0g to 180g, with an average of 87.21g.

The daily amount of fruit offered had the closest relationship to the reported dental health ratings ($r= 0.53$, $n= 12$, $p = 0.07$). The mix of greens and browse biscuits was the next highest ($r= 0.28$, $n= 12$, $p= 0.37$). The amount of greens alone had the weakest relationship with the dental health ratings ($r= 0.13$, $n= 12$, $p= 0.68$).

The percentage of fruit in an individual's diet was also most closely correlated with dental health ($r= 0.45$, $n= 12$, $p= 0.13$). The percentage of greens had a negative relationship with the dental health ratings ($r= -0.22$, $n= 12$, $p= 0.49$). The percentage of greens and browse biscuits combined had the weakest relationship with dental health of any category analyzed ($r= -0.09$, $n= 12$, $p= 0.78$).

The significance of my results is unfortunately severely limited due to a small sample size. I also received only two dental

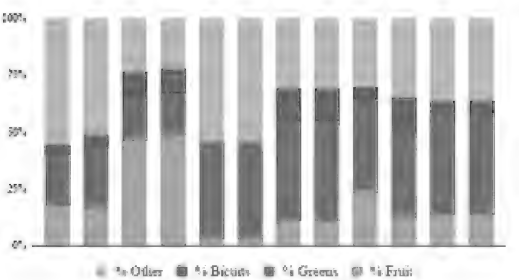

Figure 2. The diet of each siamang in the survey by percentages of fruit, greens, biscuits, and other items.

Dudlee. Photo courtesy of Point Defiance Zoo & Aquarium.

health ratings below a 4. It is possible that poor dental health in siamangs is not as common as I had believed. It also could be that facilities whose siamangs have poor dental health were less inclined to participate in the project.

Discussion and Conclusion

My results suggest that the amount of fruit in a siamang's diet is more closely correlated with its dental health than the amount of greens offered in its diet. My data also suggest that siamangs with more fruit in their diet tend to have better dental health. If siamangs are primarily frugivores, it is feasible that their teeth may not be highly affected by fructose. Fruit may also provide the nutrients they need for overall health.

The scope of this study was fairly limited in design. This project evaluated the current diets of siamangs, but did not account for past diets at their current or former facilities. A more comprehensive survey or experimental research could provide a more complete look at the effects of diet on dental health in siamangs. My rating system for dental health was also inexact. It potentially allowed for similar situations to be interpreted as different ratings by different respondents. If a more detailed system were developed, it may yield more significant results.

The responses I received inspired some observations outside of my research question. Lappan (2009) observed siamangs feeding on the fruits, leaves, and flowers of fig trees more often than on those of other plants. However, only one facility indicated that their siamangs are regularly offered figs. There were also no facilities which indicated that their animals receive browse of any variety.

Further research would be useful, on this topic and others, for improving the health of siamangs through the formulation of their diets. While research on other primate species exists, it may not be wise to generalize this information to siamangs as their dietary habits are different from even their closest extant relatives. The understanding of captive species is vital to ensuring their welfare, and the understanding of siamangs is currently lacking.

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Cho Cho. Photo courtesy of Point Defiance Zoo & Aquarium.

How to Raise a Princess: Assist-rearing a *Eulemur mongoz* infant

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Introduction

Hope for the best, but be prepared for the worst. That maxim is how the staff at the Primate House at the Saint Louis Zoo approach any of the challenges they face when it comes to managing the animals in their care. When it comes to an impending non-human primate birth, the best that can be hoped for is to have an easy birth that leads to a healthy infant or infants and a mother that is completely willing and able to care for her offspring without assistance. Unfortunately, that is not always the case and there are times when animal care staff and/or veterinary staff must intervene to help the mother, the infant(s), or both. This was the case on 19 March 2018, when a mongoose lemur *(Eulemur mongoz)* infant named Princess Buttercup was born. Dahlia, the mother, needed some assistance from the animal care staff in order to help Princess Buttercup survive. Because the animal care staff had planned for the worst, the Primate House team was prepared to come to their aid.

Background Birthing History on Parents Snuffy and Dahlia

In the fall of 2014, the Saint Louis Zoo received two mongoose lemurs from two different AZA institutions. The pair had a breeding recommendation. The one-and-a-half-year-old male, Snuffy, was introduced to the two-and-a-half-year-old female, Dahlia.

Prior to the birth of Princess Buttercup in 2018 the pair had experienced a series of four unsuccessful births. Two were

Picture 1: Sire Snuffy. Photo by Ethan Riepl.

stillbirths in April 2015 and September 2017. The other two were instances where the infant did not live for longer than a week.

In the first instance on 6 March 2016, an infant was born and appeared strong and clinging to Dahlia's abdomen. Dahlia groomed the infant but appeared uncomfortable when the infant tried to nurse. When the infant would attempt to nurse, she would push the infant away from her mammaries and would spin in a seated position. As time progressed the infant was seen nursing for short durations of up to one minute and appeared to remain strong. The father, Snuffy, was allowed to remain with Dahlia and the infant, and Dahlia appeared tolerant to his presence. He did not show any aggressive tendencies towards the infant, but he did start to become more assertive grooming and trying to take the infant as Dahlia continued to push the infant away during nursing. On 10 March 2016, animal care staff became increasingly concerned when Dahlia was observed holding the infant at arm's length, and Snuffy was able to take the infant from Dahlia. Dahlia quickly took the infant back, but the infant began to appear weaker. The infant was separated from Dahlia and placed in an incubator which allowed for the animal care staff to provide supplemental care overnight. Plans were in place to return the infant to Dahlia the next day, however, the infant's condition continued to deteriorate and the infant died on 11 March 2016.

The second case followed a very similar behavioral pattern for Dahlia. An infant was born on 11 March 2017 and was briefly pulled twice on the first day to check its health, weight and to be given fluids. On the following day the decision was made to initiate assisted nursing sessions where the mother was sedated and restrained while the infant was placed on her mammaries. The infant was regularly weighed and hydrated during these sessions which continued into the third day. On the fourth day, Dahlia and infant were moved into a lemur-sized crate in a different location away from the sire and other animals, to help reduce disturbances, which is a protocol that has been thought to stimulate maternal behavior in similar situations with lemurs (Williams 2002). Well checks and feeding sessions continued several times a day, but the infant continued to lose weight and passed away on 14 March 2017.

Even though both of these births were ultimately unsuccessful, the Primate House staff learned valuable lessons about the pair's behavior which informed changes to their birth plan. Dahlia and Snuffy were also developing their own skills. With Dahlia, there were indications that she could potentially be a successful mother in the future, such as cleaning the baby and keeping the baby warm. It was decided to continue breeding the pair in hopes that they would raise their next infant.

Research and Planning before Buttercup's Birth

The Primate Unit prepares birth plans for all breeding groups. The main documents and publications used as guides to prepare for an upcoming mongoose lemur birth include: the "Lemurs" chapter in the book *Handrearing Wild and Domestic Mammals* (Williams 2002), the *Eulemur Care Manual* (AZA PTAG 2013), and the *Eulemur SSP Birth Planning Policy* (AZA PTAG 2015). Prior to an upcoming birth, the team meets to discuss and update the plan based on new knowledge obtained and the previous year's experiences. The idea behind the

Picture 2: Dam Dahlia. Photo by Ethan Riepl.

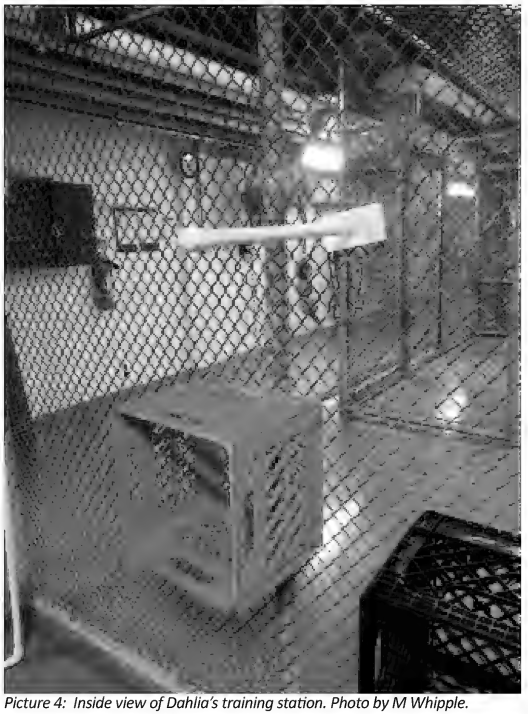
Picture 3: Outside view of Dahlia's training station. Photo by M Whipple.

birth plan itself is to prepare for both the best situations and the worst situations that could occur, along with anything in between.

The birth plan template that is used by the Primate House keeper staff includes the following sections:

- **Supplies:** behavioral observation sheets, observational cameras, formula, feeding supplies, thermometers, blankets, kennel, scales, incubator, etc.
- **Possible changes from the dam leading up to birth:** weight change, increased grooming of genital area, mammary development, etc.
- **Pre-birth preparations:** animal training, infant proofing, camera monitoring system, etc.
- **Scheduling:** keeper work schedules based on various scenarios
- **Access/Separation/Reintroduction:** plan for locations in which to house the dam and the sire prior to birth and post-birth and how animal care staff access the animals and those spaces (including any restrictions) including plans for the sire being separated, ability to howdy sire to dam and infant, and reintroductions with options outlined for both non-intervention and intervention scenarios
- **Nursing criteria:** descriptions of positive nursing behaviors versus negative or concerning behaviors around nursing for either the dam or the offspring
- **Non-intervention (Post birth):** outline the plan if the dam is able to take care of the infant without assistance from the keepers (i.e. considerations for weight checks, considerations for a "well infant" check-up with veterinarian, etc.)
- **Intervention (Post birth):** outline criteria to look for what would signal the need for intervention and the criteria and procedures for the possible intervention options including supplemental feeding, assist-rearing, and hand-rearing as well as including considerations for veterinary and nutritional staff involvement
- **First week:** outlines possible first week post-birth plans with consideration for non-interventions and various possible intervention scenarios
- **Infant information and milestones:** information about normal birth weights at various stages, ages for various developmental stages such as trying solid food, exploring off mom, weaning, etc.
- **Diet:** information for the infant and for the dam at various stages
- **Weaning:** information for both a dam-raised infant, an infant that is supplemented by keeper staff, and an infant that receives all nutrition from keeper staff
- **Other:** any special needs/considerations for species/individuals

In doing research for an updated birth plan for the mongoose lemurs at the Saint Louis Zoo, the Primate House staff decided to reach out to other members within the AZA community who would be willing to share their expertise and experiences in order to help make the updated birth plan as comprehensive as possible. The keeper staff reached out to the Prosimian Taxonomic Advisory Group (PTAG), the *Eulemur* Species Survival Plan (SSP), Duke Lemur Center, and the Lemur Conservation Foundation (LCF) for some advice and guidance in updating the birth plan. The LCF was able to share their own birth protocols, scheduling templates, and weight charts. The information provided by all parties was invaluable in creating a birth plan for this particular breeding group.



Picture 4: Inside view of Dahlia's training station. Photo by M Whipple.

Planning for Possible Intervention

When making a birth plan, one of the major sections mentioned above is "Intervention (Post birth)." It is important to have an understanding of when an intervention may be needed and have a plan for what the intervention may look like. If a dam needs help rearing her baby, the options for the animal care staff are supplementing, assist-rearing, or hand-rearing. For the purposes of this article, supplementation is defined as nutritional support given by animal care staff in addition to the nutritional support the infant is receiving while nursing from its mother. This would occur while an infant is housed with its mother and/or other members of its own species. It should be noted that an infant could also be nursed by another lactating female of the same species. Assist-rearing is defined as all nutritional support being given by animal care staff while an infant is housed with its mother and/or other members of its own species. Hand-rearing is defined as when

an infant is reared by animal care staff in an environment away from members of its own species.

When it comes to these three options, one is considered better than the other. Supplementation is the next best thing to being mother-raised. "Infants that nurse from their mothers, even on a limited basis, are less likely to develop nutritional deficiencies" (Williams 2002). Assist-rearing would be the next best options which allows the baby to receive their complete nutrition from animal care staff, but they remain with their mother and/or other members of their species for their other needs and for proper socialization. Hand-rearing should be done "only in extreme circumstances when other options have been exhausted. Hand-reared infants are more likely to exhibit abnormal social or behavioral traits and be aggressive as adults" compared to supplemented and assist-reared infants (Williams 2002).

Veterinary and Nutrition Involvement and Support

Open lines of communication and cooperation with veterinary and nutrition staff are necessary in the day to day jobs of animal keepers and managers and has a profound impact on improving overall animal care and well-being. This is just as true with any impending lemur birth, but it is critical during situations where intervention may be needed. The portions of the birth plan that needed veterinary and nutritional staff input or involvement were highlighted, developed and discussed with them in advance to avoid any delays or miscommunication. Throughout Princess Buttercup's rearing, the veterinary staff and nutrition staff were kept up to date, were included in decision making, and provided guidance and different levels of assistance. Their involvement was integral in the successful rearing of Buttercup.

Birth and Rearing Training

With the first two unsuccessful live births, Dahlia appeared uncomfortable when the infant moved on her and even more so when the infant tried to nurse. Because of this, birth and rearing training plans were developed that would not only help increase Dahlia's tolerance of the infant moving on her and nursing, but also develop a stronger bond between the trainer and Dahlia and Snuffy in the case that keepers would need to intervene. The birth and rearing shaping plan included the following:

- Station training: animals sit at their stations and hold their position to allow their trainer to safely enter their habitat with them and to exit the habitat after the session.
- Training bar: animal already sitting at their station is then asked to position themselves so that they are standing with their hands holding onto the training bar. This behavior places the animal into a good body position for the next training steps and keeps their hands out of the way.
- Touch training including desensitization to novel objects: with Dahlia's history of not allowing her infants to nurse, the primary purpose of the touch training was to get Dahlia used to things touching her that were not her or Snuffy, particularly on her abdomen and chest where the infant would be most often. It was also important to build duration onto Dahlia's tolerance of keepers and novel objects touching her.
    - Touch training: animal allows the trainer to touch their abdomen, back, legs, and chest area including the mammaries and the area around them.
    - Palpation training: animal allows the trainer to gently press on their abdomen to check for pregnancy and to mimic the feeling of an infant being on that area, and allows the trainer to press on the chest area including the mammaries to mimic some of the sensations of an infant nursing.
    - Desensitization to novel objects with touch training: animal allows trainer to touch them with different novel objects in order to mimic the feeling of an infant on them, an infant nursing, or other things that might need to touch them if the animal care staff needed to assist in rearing the infant.
        - Novel objects used: 1mL syringe, 3mL syringe, syringe sleeve, wooden stick cotton swab (using both ends to touch them for different sensations), paper stick cotton swab with a thicker head (both ends used as well), syringe cap, toothbrush, and small plush primate toy
- Flash desensitization: animals do not react when a flashlight or camera flash are used near them.
- Separation training: animals allowed themselves to be separated from one another during training sessions. The purpose of this behavior was to prepare them for the possibility of being separated after the baby is born.
- Crate training: animals enter crates separately and allow the trainer to close them in.
- Second person training: animals allow the presence of other people during their training sessions with their trainer. A second person (either an intern or another keeper) would occasionally be asked to observe a training session.

Safety equipment:

- The reinforcer used was mashed banana and raisins fed on a spoon or on the stick end of a clean cotton swab or skewer versus hand-feeding for additional safety.
- The trainer wore a puncture resistant glove and either long sleeve fleece or Kevlar sleeve on the hand and arm used for palpation and touch during training session. A latex glove was worn over the puncture resistant glove as the animals are used to keepers with latex gloves on.

Set-up Plan and Location

Ahead of the birth, Dahlia and Snuffy were moved to the holding area that would remain their home throughout the

rest of Dahlia's pregnancy and after the birth of the infant. This allowed time for Dahlia and Snuffy to become comfortable with the new space. It also allowed time for keeper staff to work on the birth and rearing training with them. This habitat was indoors, away from public view and would provide keeper staff the flexibility to restrict the space as needed. Any groups of species with loud vocalizations were moved away from this area to keep distractions to a minimum. This space would also allow for the male to be separated but still able to see, hear, and smell Dahlia and the infant. Prior to the birth, they were given access to the entire holding area. Once the infant was born, they were separated. For the purposes of this article, their living space will be referred to as holding A, B, C, and D. Holding A is the largest of the four spaces measuring 2.84m tall X 3.51m wide X 6.93m long. Holding B is measured at 2.44m tall X 1.83m wide X 1.83m long. Both holding C and D each measure at 1.83m X 1.83m X 1.83m. Snuffy was given the larger holding A space in addition to holding B, while holding C and D were reserved for Dahlia and her infant (Figure 1).

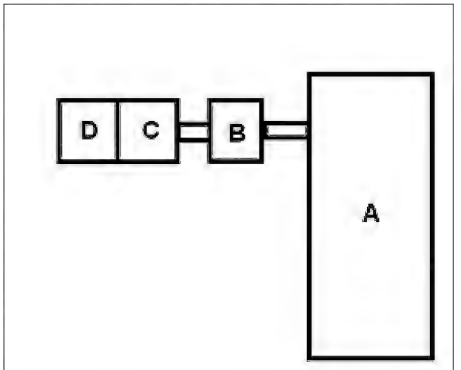


Figure 1: Layout of "birth suite" habitats.

The area where they were housed was an ideal location for use as a "birth suite" for Dahlia whether she was able to raise the infant on her own or if an intervention was needed, as was the case with the birth of Princess Buttercup. The walls of holding A are mostly mesh with a concrete ceiling and a portion of solid concrete wall dividing it from the room where holding B, C, and D are located. Holding B, C, and D have all mesh walls and ceilings. Holding B is connected to holding A via a 0.41m tall X 0.41m wide X 1.83M long tunnel that has solid metal shift doors at each end that can be closed. It is also connected to holding C via a 0.41m tall X 0.41m wide X 0.81m long mesh tunnel that also has solid metal shift doors on either end that can be closed. Holding C and D share a mesh wall and have one solid opaque acrylic shift door to allow passage between the two areas. Because all of the holding spaces were mesh, the family had visual, auditory and olfactory access throughout the entire process.

To make the space safer for the infant, clear acrylic panels were added over areas where mesh greater than 2.54 cm squared was present and thick comforters were placed on the ground over wood wool to prevent a fall hazard. Modifications would be made as the infant grew and ventured away from her mother such as more perching and the removal of padding on the ground. Other preparations were made to the holding areas prior to the birth including adding cameras to help keepers monitor the dam and infant. Shelves and crates were also added for use in separation and crate training within the holding areas.

The Birth of Princess Buttercup

Princess Buttercup was born on 19 March 2018. It soon became clear that the keeper staff would need to intervene. Even though Dahlia appeared much more comfortable with the infant being in the nursing position, she would not allow the infant to actually nurse for very long. For this situation, the protocol in the birth plan was to place the dam and the infant in a lemur-sized crate to encourage bonding and to help ensure the infant would stay warm (William 2002). The plan was to make this move into the crate immediately, rather than wait as had been done in the past. Because of the training, Dahlia was easily separated from Snuffy and crated. Dahlia's behavior would dictate how long she would remain in the crate with her infant. The Primate Keeper staff wanted Dahlia to bond with her infant but not become overly stressed by the situation. Eventually, Dahlia and Princess Buttercup were moved into a larger crate to give them more room. In total, Dahlia and Princess Buttercup spent 14 days together in a crate.

This was first approached as a supplementation intervention, and keepers had to net Dahlia out of the crate every two hours in order to pull the infant for a supplemental feeding, check the infant's rectal temperature and weigh her. (It should be noted that the number of times the infant's temperature was taken decreased to once a day and then was discontinued.) A few days into this process, animal care staff tried to incorporate assisted nursing sessions twice a day

Figure 2: Weekly feeding schedule from birth through weaning using the 24-hour clock.

Week 1-2	Week 3	Week 4	Week 5	Week 6	Week 7-8	Week 9-10	Week 11-12	Week 13	Week 14-23
0130	0230	0215	0115	0115	0515	0615	0730	0800	0800
0330	0530	0515	0515	0515	0915	1115	1130	1200	1600
0530	0730	0815	0815	0915	1315	1715	1630	1600	
0730	0930	1115	1115	1315	1715	2315			
0930	1130	1415	1415	1715	2315				
1130	1330	1715	1715	2115					
1330	1530	2015	2115						
1530	1730	2315							
1730	2030								
1930	2330								
2130									
2330									

with Dahlia hand restrained to stimulate milk production, and the veterinarians prescribed medication to promote milk let down. It was found that she had little to no milk, and the situation switched from a supplementation intervention to an assist-rearing one. As time went on the procedures changed for how much space Dahlia and Princess Buttercup were allowed and how the infant was fed.

Feeding

Per the assist-rearing and supplementation procedures, the keeper staff started to feed Princess Buttercup every two hours. During the first 24 hours Princess Buttercup was fed 5% dextrose with bottled water. On Day 2 she was fed ½ formula with ½ 5% dextrose solution. On Day 3 she was fed ¾ formula with ¼ 5% dextrose solution. By Day 4 she was being fed full formula. The formula consisted of: 1 scoop of human infant formula powder, 60ml of bottled water, 60ml of non-fat milk, and 6ml of 50% dextrose solution (adapted from Williams, 2002). These ingredients were all mixed together in a small sanitized container.

Initially, the feedings required two people present, as the

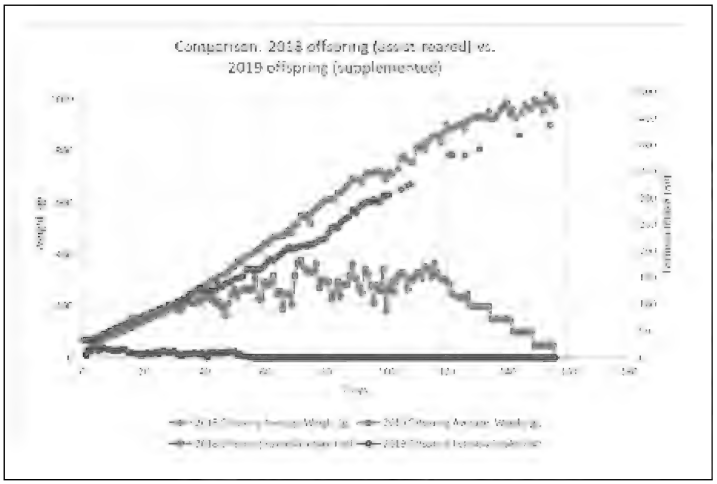


Figure 3: Comparison of Princess Buttercup (2018) and Mr. Hooper's (2019) average daily weights and formula intake.

Picture 5: Examples of items used during Dahlia's training sessions. Photo by M Whipple.

Picture 6: Princess Buttercup on Dahlia. Photo by Ethan Riepl.

keeper staff had to enter the holding area where Dahlia and Princess Buttercup were staying in a crate. The primary keeper was responsible for catching and restraining Dahlia, while the secondary keeper carefully pulled Princess Buttercup off of her mother. The secondary keeper would then place Princess Buttercup on a small, stuffed animal that had been warmed for the infant to cling to while the keeper fed Princess Buttercup with a 1ml syringe. Princess Buttercup started with consuming no more than 3ml of formula during a feeding but at the peak of her formula feedings she was consuming 60ml. In general, it was recommended that she consume 25% of her body weight daily to help promote growth (Williams 2002). Her weights were closely monitored to make sure her weight trends increased. As she progressed with the amount she was eating, the keeper staff increased the syringe size and how many syringes were brought to the feeding. The syringes were prepared beforehand in the kitchen area where everything had been sanitized then placed into a warm bowl of water to keep the formula warm. Princess Buttercup showed a preference for warmed formula compared to the cold formula taken right out of the refrigerator. However, during the weaning process the keeper staff began to just feed her the cold formula to encourage consumption of other foods. The keeper staff attempted to add a nipple to the syringes at different points but it was determined that Princess Buttercup much preferred eating from the syringe.

At 14 days old, Dahlia and Buttercup were let out of the crate and given more living space in holding C. At this point the primary keeper entered the animal space for the feedings, with the secondary keeper as the back up at the keeper door. The primary keeper would feed Princess Buttercup as she clung to Dahlia. Though less invasive than being restrained, Dahlia appeared agitated with the keepers in her space and after a few days it was found to work better to feed Princess Buttercup through the mesh from outside of the animal space. Initially, Dahlia brought the infant to the keeper but within a few weeks Princess Buttercup was approaching keepers independently to be fed. At this point only one keeper was needed for feedings. Around the third week, Princess Buttercup began to sample different food items, including raisins, cooked squash, grapes and soaked primate biscuit. Solid foods offered were either softened or cut small to avoid potential choking hazards. At four-weeks-old the keeper staff began adding 1g of biscuit dust per 100ml of formula to the syringes. After several days of this method it was stopped due to issues with the biscuit dust clogging the syringes as well as Princess Buttercup's aversion to it being in the formula. Since she was eating soaked biscuits, the animal care staff and nutritionist decided this was unnecessary. Extra amounts of food items were added to Dahlia's diet as Princess Buttercup's interest in solid food increased.

After Snuffy was reintroduced to the group, both parents began attempting to consume the formula, resulting in the keeper staff separating them from Princess Buttercup for feedings whenever possible. When Princess Buttercup was almost fully weaned from formula the keeper staffed increased the mongoose lemur family's diet to three adult individuals (Figures 2 and 3).

Picture 7: Princess Buttercup being fed. Photo by Ethan Riepl.

Picture 8: Mr. Hooper being fed. Photo by M Whipple.

Weights

Initially, weights were taken at each feeding to track growth. While the infant was physically being handled by keeper staff at feedings it was easy to weigh both before and after. As the infant grew and began accepting formula while still holding onto the mother, the keeper staff felt it would be stressful on both mother and infant to attempt to weigh the infant. It was decided that as long as the infant was strong, she was not pulled to weigh.

Once Princess Buttercup began to venture off of her mother to find food, keepers placed a small battery-operated scale on a shelf inside the habitat. The scale was secured to the shelf so that it could remain with Dahlia and the infant around the clock. A mesh platform made from a modified suet feeder was affixed to the scale platform to help the infant hold onto it. Keepers were able to lure her onto the scale to be weighed both before and after feedings. When she grew bigger and the housing of the animals changed, she was weighed on a larger scale. All weights were attained by the free choice of the mongoose lemur infant after three weeks of age (Figure 3).

Introduction to Snuffy

The introduction of the sire Snuffy was approached with caution. There had been anecdotal evidence that a male initially removed from the rearing situation could cause harm to the infant when reintroduced (A. Grand, personal communication, 2 February 2018). It was with this knowledge that the birth plan included strategies that allowed Snuffy to be present for the entire rearing process but remain physically separate. Snuffy was housed in a space that had visual, auditory and olfactory access to Dahlia and Princess Buttercup at all times. Blankets were exchanged between the groups throughout the process for greater olfactory access. A tunnel with doors closed on both ends separated the male in holding A and B from the female and infant in holding C and D.

When Princess Buttercup was capable of moving from her mother confidently at five weeks of age, she and Dahlia were given access to the tunnel area. A solid door was in place to prevent fingers from sticking through the mesh. Eventually a mesh panel was placed over the door frame and the door was opened leaving the mesh panel in place. All of them showed great interest in one another through sniffing, nose touching, grooming, vocalizing and scent marking. The solid door was closed overnight on the first day, but on the second day it was opened permanently. A week later, Snuffy was given full access to Dahlia and Princess Buttercup. No aggression was shown and Snuffy had an interest in interacting with Princess Buttercup in a positive manner. Dahlia did not become defensive of Princess Buttercup and spent time interacting with and grooming Snuffy. Dahlia did not hesitate to reprimand Snuffy if he became too rough with Princess Buttercup. It was decided that separation of the two may cause frustration and so they were left together from that point onward without incident. The family had the run of holding B through D. Primate staff continued to keep the floor bedded for Buttercup's safety.

Princess Buttercup's Public Debut

After many critical milestones had passed and supplemental feedings were being phased out, the mongoose lemur family

was moved to a large, publicly-viewed habitat on 25 June 2018. The habitat was heavily bedded with wood wool and perched with plenty of branches for Buttercup to hone her climbing and jumping skills. Masking tape was placed on the habitat windows to provide something solid for Princess Buttercup to learn what glass was. Visitor viewing was roped off to keep the public back from the glass. The neighboring habitat that shares a glass wall was kept vacant to allow Buttercup to build confidence in her new home.

After two days without incident, the animal care staff allowed the pair of Allen's swamp monkeys *(Allenopithecus nigroviridis)* to return to the habitat adjacent to the habitat the mongoose lemurs occupied. The mongoose lemur family showed signs of stress at first but handled their new neighbors well, and were relaxed again within a few days. Buttercup showed little to no signs of stress when the public was allowed to approach the glass and she remained very playful. The tape on the glass windows was eventually removed and the bedding on the floor was reduced to normal amounts of substrate as Buttercup was showing ample ability to move around without falling.

Maintaining staff communication during this time was of extreme importance and was an essential part of the team's success.

It Takes a Village: Scheduling, Overnights, Communication and Trying to Balance

One of the biggest challenges to assist rearing an infant is scheduling, but having a great, hardworking, passionate team that was willing to be flexible with their own lives helped. The Primate House team assigned to care for Princess Buttercup consisted of five full-time keepers, one swing keeper, two seasonal keepers, two zoological managers, and one curator. The team had to coordinate a schedule that allowed for twenty-four-hour coverage with a minimum of two staff members present for each of the feedings. Newer staff members had to be trained quickly in capture and restraint techniques in order to ensure there were two trained staff members at each feeding. The feedings began at two-hour intervals on the half-hour time periods. Placing feedings on the half-hour mark allowed the team to be scheduled in at the top of the hour. This provided thirty minutes for the keepers to prepare for the feeding. Initially, there were five nine-hour shifts that were staggered throughout the day (including an hour for lunch) and started at 0500, 0900, 1300, 1900, and 2300 hrs. These shifts were primarily covered by the keepers, usually with no more than two keepers scheduled at any given time throughout the 24-hour day. Later, as the intervals between feedings were increased, shifts were adjusted accordingly and eventually sign-up sheets were used to facilitate the overnight feeding times.

On a normal work day, there would usually be four keepers working together. One keeper would work from 0700 to 1600 hrs. while the rest of the staff would work from 0800 to 1700 hrs. Having only two keepers scheduled at a time presented unique challenges. To accomplish cleaning and regular husbandry of all species in the department, the work day was expanded to 0600 and 2000 hrs. with most of this work centralized in the morning.

Maintaining staff communication during this time was of extreme importance and was an essential part of the team's success. The staggered shifts helped the team more easily pass along information. When a new shift began, they would do their first feeding with another staff member that had already done multiple feedings during their shift and could report any subtle behavior changes, successful feeding methods, and other useful information. A laminated checklist containing each of the animal groups was prepared and listed all required work that must be completed daily for each group such as cleaning, diets, medications, supplements, enrichments, and so on. Diet preparation, non-animal area cleaning, and open/closing duties were also on the daily checklist. Once completed, the keeper would initial next to each task with a dry-erase marker until every duty on the checklist was finished. Each morning the list would be wiped clean to start again. This checklist was necessary to ensure that everything that needed to be done actually got done.

Another useful tool used in staff communication was the Mongoose Lemur Infant Data Sheet. This form was used to record information from each of the infant lemur feedings. The date, time, observer, what was fed and how much, weights (before and after originally), and any additional comments were all recorded on this form. Urination and defecation were originally recorded, but it was difficult to collect data once the infant was no longer being held for feedings. Any temperatures taken were also recorded here.

Once information was recorded onto the Mongoose Lemur Infant Data Sheet, it was then transcribed into a computer database. This allowed the team to develop graphs showing the daily average body weight, average amounts of formula fed, and daily changes in both. The graphs allowed staff to easily see any fluctuations in data and allowed for easy comparisons with other individuals in populations where similar data were collected. Updates based on these data were e-mailed to the Primate staff, the veterinarians and other Zoo leadership daily.

Conclusion (to this chapter, but not the end of this article...)

The Primate House staff hoped for the best, but prepared for

the worst. Because of this, the staff was ready when Princess Buttercup was born. In this case, intervention was needed in order to help Princess Buttercup survive and continue to thrive. The choice to assist-rear this infant mongoose lemur provided many challenges, but the benefits of being able to keep the mother and infant together outweighed all of the extra work that had to be put in to make the endeavor a success.

There were three vital pieces that were integral to raising this Princess. The first of those occurred before she was even born which was the **planning** process. The Primate House staff felt that having a birth plan and a birth and rearing training plan for Snuffy and Dahlia greatly contributed to the success of the assist rearing of Princess Buttercup and her survival. The bonds created by training closely with keepers may have also contributed to Dahlia's tolerance of all of the intrusive aspects that come with keepers assisting a dam in rearing an infant. The second vital piece was **teamwork**. The team was willing to be flexible with scheduling and work load, to learn from each other, and to have open discussions with one another. The third vital piece was **communication**, which was essential for the whole process to go smoothly and make certain that no animals or people were forgotten.

Princess Buttercup has since celebrated her first birthday. The planning and hard work of the team, Dahlia, and Princess Buttercup all together led to a successful and celebrated outcome that not only increased the level of care the team could provide, but also the experience the team has with mongoose lemurs and assist-rearing. Of course, the process does not end with the successful weaning of Buttercup or even with the celebration of her first birthday. The staff will continue to have follow-up reviews of the birth and rearing process which will be helpful in identifying challenges, successes and what changes should be made to future birth plans.

(...because there is) A New Baby and a New Chapter

Princess Buttercup was an example of a successful assist-rearing. However, there may be indications that the efforts that had been put forth to help Princess Buttercup survive and thrive may have also helped Dahlia to improve her own mothering skills. The indicator being the birth of a male offspring, Mr. Hooper, on 12 June 2019. Though Dahlia and Mr. Hooper still needed some assistance from the animal care staff, this time around the staff was able to move to just supplemental feedings and not full assist-rearing.

At first, Dahlia would not allow him to nurse, and was again observed pushing the baby away from her mammaries repeatedly. Because of her history and because of the experience the staff gained in assist-rearing Princess Buttercup, the staff took time to reevaluate and make changes to the birth plan prior to Mr. Hooper's birth. These changes included intervening earlier and moving the birth suite location. The staff started assisted nursing sessions twice a day earlier. This allowed the veterinary and animal care staff to check for milk production right away, and at approximately six hours after birth there was milk let down. This earlier intervention also allowed for the animal care staff to obtain a birth weight and for the veterinarian to administer a medication that would promote milk let down. The birth suite location that was selected was away from other animal groups and allowed Snuffy and Princess Buttercup to be housed directly next to Dahlia and Mr. Hooper with small mesh access to one another.

With the changes in place, Dahlia's milk production increased, she started allowing the infant to nurse, and Mr. Hooper started gaining weight in between supplemental feedings. Assisted nursing sessions ended after week one. Two days later after that, the animal care staff was able to switch to supplemental feeding every three hours. Due to an overabundance of caution, the supplemental feedings were reduced slowly over time and at eight-weeks-old the supplemental feedings were no longer needed and Dahlia took over full care of her infant. With Princess Buttercup able to see her mother raising her sibling, it is hoped that she will learn some important lessons about mothering behaviors (Figure 3).

Acknowledgments

Thank you to PTAG chair Christie Eddie from Omaha's Henry Doorly Zoo, *Eulemur* SSP coordinator Gina Ferrie from Disney's Animal Kingdom, Alison Grand and Caitlin Kenney from the Lemur Conservation Foundation, and Cathy Williams from Duke Lemur Center for sharing their invaluable knowledge and expertise. The authors would like to thank the rest of the Saint Louis Zoo's Primate House Staff including Ethan Riepl, James Kelton, Brooke Johnson, Helen Boostrom and Heidi Hellmuth in addition to extra support provided by Jungle of the Apes staff including Dawn Boyer and Spencer Wilson, as well as other Zoo staff including Carol Fieseler, Shannon Santangelo and Mandi Nordin. A special thank you is due to swing keeper Rachel Koebert. Thank you to the Saint Louis Zoo's animal division leadership, veterinary staff, animal nutrition staff and security staff for the support and help they provided.

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Portions of this article were presented at the 2019 Prosimian Taxonomic Advisory Group (PTAG) meeting and workshop in Dallas, Texas and at the 2020 Animal Behavior Society virtual conference.

Voluntary Eye-Drop Training with 1.0 Military Macaw

Jessica Egerer
Bird Department Zoo Keeper at Detroit Zoo, Royal Oak, Michigan
Work took place at Saginaw Children's Zoo (Prior Animal Collections Zoo Keeper) Saginaw, Michigan

Introduction

Patton, a mid-aged military macaw (*Ara militaris*), came to the Saginaw Children's Zoo as a result of being rescued from the illegal pet trade. As Patton aged, he began to develop a cataract in his right eye. Despite Patton's unfortunate history, original distrust in humans, and due to the importance of animal welfare, a training plan was written and implemented to reduce stress and simultaneously improve eye health for the bird. Patton acts as an ambassador for a species that is, unfortunately, vulnerable in their home range of South America.

Preliminary Training

An important aspect to consider is the time spent earning Patton's trust and building a relationship with him. When I first began working with Patton he was extremely reactive and would often lunge at the mesh as I walked by. Although we formed a trusting relationship over time, to give him comfort and keep both myself and Patton safe, all of the approximations represented in this training plan were conducted via protected contact. Training sessions were conducted with Patton three to five days per week, with some days having the occasional double session. They were kept between five and fifteen minutes so as to not lose interest from the subject. Sessions were always ended on a positive note to encourage involvement during the next session. A clicker was used as a bridge; reinforcement included sunflower seeds, various nuts or grapes. Jackpot reinforcers consisted of whole exotic nuts and were commonly used after an initial progression, consistent sequence, or at the end of a session.

Photo from training session shows Patton stationed and holding.

As a precursor to the voluntary eye-drop training, Patton learned a "station" behavior. Patton's station consisted of a tennis ball attached to a carabiner clip [see Appendix A]. The station was placed on various locations of the mesh while the verbal cue "station" was spoken. Approximations started simply; Patton would be bridged and reinforced for simply looking at the station, then for moving toward the station. Finally, he was bridged and reinforced differentially for having his body directly under the tennis ball. Eventually, presenting the tennis ball, tapping it, or moving it to a new location became the cue. Patton recognized what his position needed to be in relation to the station in order to be positively reinforced.

Approximations

1. Maintain a successful station: Attach tennis ball station to the mesh and bridge/reinforce once the parrot had stationed.
2. Incorporate "hold position" goal: The verbal cue "hold" was used, and the parrot's behavior was bridged and reinforced once he had grabbed the mesh with his beak.

Photo from training session shows Patton's cataract (right) eye.

Photo from training session shows Patton holding beak to mesh while syringe is in place.

This behavior was differentially reinforced for duration of his hold on the mesh. Often times when shaping this behavior, I would count in slow paced, one-second increments to help the parrot understand it was longer duration that received reinforcement.

3. Desensitize the syringe: The 3mL syringe had a catheter tip attached to it to add length to the apparatus, allowing us to work through the mesh and get fluid into Patton's eye. Before incorporating the syringe directly into training, Patton was desensitized to the object. The syringe was shown to Patton in a non-training setting and always was coupled with positive interactions, including offering food reinforcers. After Patton was comfortable with the eye drop apparatus, the verbal cue "hold" was used while positioning the syringe with catheter tip through the mesh toward the bird's eye. I would then bridge and reinforce when Patton grabbed the mesh with his beak and remained calm in the presence of the syringe [See Appendix B & C]. Once more, this behavior was shaped to increase the duration of the parrot's hold on the mesh, while remaining calm in close proximity to the syringe.
4. Introduce eye-drops: Once Patton began consistently holding his beak to the mesh with the syringe near his eye for twenty-second increments, the verbal cue "drop" was used to indicate the administering of water into his eye. Patton's behavior was initially bridged and rewarded immediately after the drop, regardless of whether he pulled his head away from the mesh or not. Over time, the behavior was shaped to encourage Patton remaining calm and reacting less, keeping his beak held on the mesh following the eye drop. In shaping this behavior, water was used in place of eye-drop solution.
5. Final approximation: Parrot positions body on the mesh near tennis ball station and holds beak to mesh, giving three points of contact. While the parrot's beak and feet are secured to the mesh, parrot will allow trainer to administer eye drops into open eye (using syringe with catheter tip) through mesh. Trainer will bridge and reinforce for calm behavior throughout process.

Plan Specific Comments

It is highly recommended to always seek veterinary approval before applying any type of fluids to an animal's eyes for training purposes. If animals being trained are ever in the same holding as another conspecific, consider incorporating multiple trainers or separating animals to avoid aggression or distractions during training. Throughout the progression of this training plan I remained Patton's primary trainer. When I transitioned to a new position, Patton's training was continued with Megan Ohlrich as his primary.

Training Outcomes

As a main result of incorporating positive reinforcement training with Patton, he became more trustworthy around people and has proven his intelligence and eagerness to learn. Throughout the training process there were occasionally setbacks that would require the progression to occur at a slower pace. However, it only took approximately one week of consistent sessions before Patton learned his station behavior and the "hold" cue was introduced. Once the initial introduction of the "hold" cue took place, Patton began picking up the behavior, and within approximately two weeks his hold behavior was exceeding lengths needed to begin desensitizing him to the syringe apparatus.

Just a few weeks later the syringe had become a part of the training sessions. At this time, it became clear that the behavior needed to be taught for both eyes, since the lack of vision in his bad eye resulted in less reaction from the syringe. As Patton was consistently rewarded for remaining calm in the presence of the syringe (near either eye) we worked toward introduction of the "drop" cue. This cue introduced the incorporation of fluid and was shaped in attempts to capture the final target behavior. Ultimately, Patton learned the voluntary eye drop behavior successfully in both eyes, preparing him for potential future surgery and opening the door for more training opportunities.

Conclusion

With the use of positive reinforcement, Patton learned to successfully and voluntarily have fluid applied to

both of his eyes. It is anticipated that following potential cataract surgery on his right eye, the eye drop behavior will have been maintained well enough for him to readily participate. Patton's participation in receiving eye drops post-operation will be voluntary and much less stressful due to the success of this trained behavior.

Throughout the training process, Patton experienced a few unmotivated sessions, but mostly showed constant improvement and willingness to learn. Although Patton was typically eager to participate, there were a few times that he became overstimulated and lunged at the mesh. For these reasons, the consideration to train this behavior protected contact was a positive one. Protected contact allows for a safe environment for both the trainee and the trainer, as well as encouraging comfort.

Training protected contact with Patton also allowed for a very obvious way for the parrot to leave a session if he chose. Patton recognized that all of our sessions took place at the mesh, with use of his station. Although it did not happen frequently, Patton did leave sessions and would do so by moving away from the mesh and remaining there.

This behavior could later lead into new training opportunities, including a "wing" behavior where the macaw displays his wings to be looked over, or a voluntary nail-trim behavior in which the macaw displays his toenails to be trimmed through mesh. This plan, if implemented with positive reinforcement techniques, could be generalized to shape voluntary eye-drop behavior in other species.

Acknowledgements

I would like to thank Megan Ohlrich, who helped with training implementation, inspiration, and for continuing the established progress. I would also like to thank Mallory Balmert of Akron Zoological Park for her constant training support and advice. This work was conducted as a part of graduate work, through Project Dragonfly at Miami University in Oxford, Ohio and in conjunction with the Cleveland Metroparks Zoo. Special thanks to my instructor, Katie Feilen, and classmates who have contributed to editing my work.

Training Tales Comments: By Jay Pratte

Some really great talking points in this Tale! Let's have a look at the two I'd like to highlight:

Experienced trainers have learned, over time, how to effectively use differential reinforcement (DR) to both improve communication with their animal(s) and their skills as a trainer. The science of operant learning tells us that a more valuable "consequence" (reward) will greatly increase the occurrence of a goal behavior in the future. The art of practice and skill development involve the nuances of knowing your individual, their reward preferences (which may change daily or over time), and even their motivation during a single session (which, heaven knows, for many species can change in an instant!). In this Tale, the author describes how they set the process up and planned for differential reinforcement ahead of time, preparing themselves for any learning leaps forward, yet are also then ready for potential regression, or changes in circumstances that might impact motivation.

"…reinforcement included sunflower seeds, various nuts or grapes. Jackpot reinforcers consisted of whole exotic nuts and were commonly used after an initial progression, consistent sequence, or at the end of a session."

DR is such an important tool and skill to develop; I'm glad to see it represented succinctly in this plan!

As a consistent believer in and user of Keep-Going-Signals (KGS), it made me smile to see this described as part of the learning process, encouraging Patton's increasing Hold duration. "The most widely used version of the KGS is as a conditioned reinforcer, used to reinforce an animal partway through a long-duration task, such as a medical behavior, guide-dog work, or search-and-rescue efforts." (www.clickertraining.com) *I have found that a KGS, when used correctly and having been conditioned as a secondary reinforcer, can be immensely helpful to communicate with an animal that they're not quite where we want them to be yet, and to keep trying. It is an extra bit of communication that may create faster comprehension of the goal.*

"Often times when shaping this behavior, I would count in slow paced, one-second increments to help the parrot understand it was longer duration that received reinforcement." *This description is more technically representative of an Intermediate Bridge:* "The intermediate bridge is functioning as an encouragement signal or a form of intricate coaching to keep working towards the goal. It gives nonstop feedback to the animal. The signal stops when the animal starts doing the wrong thing and repeats when the animal is back on track." (www.zoospensefull.com) *However, when those encouraging signals have been assigned reward value with a primary reinforcer, they become a KGS, and another opportunity to provide a primary reinforcer periodically. This is a good example of improving our communication to our subject.*

*Lastly, I always add in "*my favorite part about this Tale is*", and this time is no exception! As both a previous pet and an ambassador animal, one would expect Patton to be very "tractable". It is not uncommon for animals that we can physically handle to experience shaping steps differently, or in an "attenuated" form, BECAUSE we can handle them. We may pick them up and put them in a crate, use our bodies to "mold" desired behaviors, or gently hold/restrain for simple procedures like eye exams or drops. By recognizing that Patton's history might make his tractable side less appealing for direct handling, opting for protected contact and adding a few steps greatly increased his comfort and motivation, as well as providing him the opportunity to leave and say "nope" if he so chose. Increasing an individual's ability to make choices for themselves generally results in improved welfare.*

Oh, and by using PC training, the team avoided adding a label, like "biter" or "aggressive" into the mindset of training goals. Avoiding labels or implied personality traits allows each trainer to approach an animal with a clear mind, allowing training steps and goals to evolve based on behavioral responses, rather than preconceived notions.

Great work and thank you for submitting your Training Tale!

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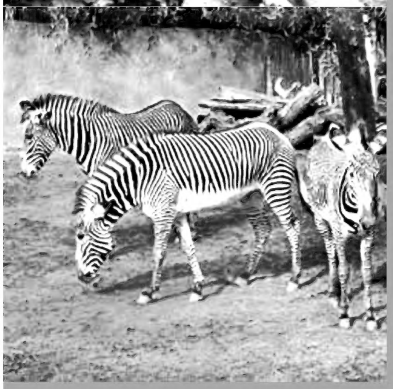

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